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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Mechanical Engineering

Semester End Examination; May/June - 2018

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

ii) Use of Thermodynamics data hand book permitted.

UNIT - I

1a. With the help of P-V and T-S diagrams, derive an expression for air standard efficiency of Otto cycle. 8

b. A diesel engine operating on an air standard diesel cycle has 20 mm bore and 30 strokes. The clearance volume is 4.2×10^{-4} m^3. The fuel is injected for constant pressure is 5% of stroke. Calculate the air standard efficiency. If cut-off is delayed from 5% to 8%, what will be the effect on efficiency? 12

2 a. With neat flow diagram and T-S diagram, explain the following gas turbine cycle : 10

i) Regeneration ii) Inter cooling iii) Reheating

b. A gas turbine receives air at 100 kPa and 300 K and compresses it to 620 kPa, with compressor efficiency of 88%. The fuel has a heating value of 44180 kJ/kg and fuel air ratio is 0.017 kg of fuel per kg of air. The turbine efficiency is 90%. Calculate the compressor work, turbine work and thermal efficiency. 10

UNIT - II

3 a. With the help of a schematic diagram and T-S diagram, explain the working of a regenerative vapour power cycle with open feed water heater and derive an expression of its overall efficiency. 10

b. A 40 MW steam power plant working on Rankine cycle operates between boiler pressure of 4 MPa and condenser pressure of 10 kPa. The steam leaves the boiler and enters the steam turbine at 400°C. The Isentropic efficiency of turbine is 85%. Determine; 10

i) Cycle efficiency ii) Quality of steam from turbine iii) Steam flow rate in kg/hr

Consider pump work.

4 a. With the help of T-S diagrams, explain the effects of varying boiler pressure and super heating on the performance of a simple Rankine cycle. 10

b. In a reheat regenerative cycle, the high pressure turbine receives steam at 20 bar, 300°C. After expansion to 7 bars, the steam is reheated to 300°C. The steam expands in a low pressure turbine to a final pressure of 0.05 bars. Determine; 10

Contd…2

i) Cycle efficiency ii) Specific steam consumption

iii) Quality of steam entering the condenser

UNIT - III

5 a. Obtain an expression for the volumetric efficiency of a single stage compressor in terms of the pressure ratio, the clearance ratio and index of expansion and explain the effect of clearance on volumetric efficiency. 8

b. A two stage air compressor with perfect inter cooling takes in air at 1 bar 27°C. The law of compression in both stages is $PV^{1.3} = C$. The compressed air is delivered at 9 bars. Calculate for unit mass flow rate of air the minimum work done and the heat rejected in inter cooler. Compare the values, if compression is carried out in single stage compressor. 12

6 a. Derive an expression for works in a two stage compressor with perfect inter cooling. Also derive an expression for the intermediate pressure for the same. 10

b. What are the disadvantages of a single stage air compressor? Explain how these disadvantages are overcome? 6

c. Why inter cooling is necessary in multistage compression? 4

UNIT - IV

7 a. Define the following :

i) Dry bulb temperatures ii) Dew point temperature iii) Specific humidity 10

iv) Relative humidity v) Degree of saturation

b. With suitable sketch, explain the following process :

i) Cooling with dehumidification 10

ii) Heating and humidification

8 a. With T-S and P-H diagram, explain the effect of super heat and sub cooling on the vapor compression refrigeration cycle. 6

b. With a neat sketch, explain the working of vapour compression refrigeration system. 6

c. A cold storage is to be maintained at -5°C (268 K) while the surrounding are at 35°C. The heat leakage from surrounding in to cold storage is estimated to be 29 kW. The actual COP of refrigeration is one third that of an ideal plant. Find the power required to drive the plant. 8

UNIT - V

9 a. Explain Willan's line method and motoring test to determine the friction power of an engine. 10

b. A four stroke four cylinder petrol engine was tested at full throttle speed. The following power measuring during Morse test :

With all cylinders working = 14.7 kW With cylinder 1 cut off = 10.1 kW

With cylinder 2 cut off = 10.3 kW With cylinder 3 cut off = 10.2 kW 10

With cylinder 4 cut off = 10.4 kW

Contd…3

The bore and stroke of each of the cylinder are 80 mm and 100 mm respectively. The clearance volume is 100 CC of each cylinder. The fuel consume is 5.44 kg/hr. The calorific fuel is 41900 kJ/kg. Calculate;

i) Mechanical efficiency ii) Indicated thermal efficiency

iii) Relative efficiency with reference to brake thermal efficiency

10 a. Explain Morse test for determination of IP of an engine. 8

b. A two stroke diesel engine was motored when meter reading was 1.5 kW. Test on engine was carried for one hour and data observed were as follows : 12

Brake torque	=	120N-m
Cp gas	=	1.05 kJ/kg.K
Speed	=	600 rpm
Room temperature	=	27°C
Fuel used	=	2.5 kg
A:F	=	32:1
Calorific value	=	40.3 MJ/kg
Cooling water	=	818 kg
Rise in temperature of cooling water	=	10°C
Exhaust gas temperature	=	347°C

Determine BP, IP, brake thermal efficiency and draw heat balance sheet on minute basis.

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